KAOLIN MINING WITH CONTINUOUS MACHINE ASSEMBLIES

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In order to guarantee effective all-year round operation of kaolin deposits with continuous machinery assemblies it is very important to make a proper selection of the methods of working and the face parameters, with regard to the specific properties of the kaolin.

Water contained in the kaolin freezes in winter time, expands, and separates one particle from another. When the ice thaws the kaolin is converted into a liquid mass with a water content of up to 40%, which predetermines the method of mining for all the year round working of the kaolin with continuous machinery complexes. In autumn and spring for 3.5–4.0 months it is impossible to use mechanical means and belt conveyors for transportation. Furthermore, the excavator can operate normally only when the caterpillar tracks operate over freshly worked areas. It is therefore very important to make a proper choice of the rational parameters of the kaolin-working system.

The Glukhovets Kaolin Combine operates ZER-500 excavators and KRLZ-500 and RT-65 belt conveyers.

The minimum rotation angle of the rotor jib on the loading side when the excavator is moving over freshly prepared fields is determined from the formula

$$\frac{h_f}{\sin \alpha} + \frac{g}{2} + C \cos \beta (f + l_j \cos \beta) \sin \psi_w. \quad (1)$$

![Fig. 1. Effect of rotational angle of the rotor jib (on the loading side) on the distance between the conveyor and the bench (l_p is the length of the overloader).](image1)

![Fig. 2. Specific costs for processing 1 m³ as a function of the working scheme of the excavator and the setting width: 1) operating without overloader; 2) using the driven overloader; 3) using the self-acting overloader (S is the width of the setting).](image2)
Fig. 3. Scheme for preparing the kaolin bench for working with preliminary breaking up of the bench roof to the frost depth and filling in the slope with kaolin crumbs.

Fig. 4. Relationship between the ratio of kaolin crumb volumes to the working space and the height of the bench.

where $f$ is the distance from the axis of rotation of the excavator to the point of suspension of the rotor jib, m; $l_{rj}$ is the length of the rotor jib, m; $\beta$ is the angle of the rotor jib when the bottom of the site or face is being cleaned, deg; $\psi_M$ is the angle of rotation of the rotor jib toward the loading site, degree; $h_{fr}$ is the frost line of the kaolin, m; $\alpha$ is the angle of slope of the face, degree; $B$ is the width of the caterpillar track, m; $C$ is the minimum permitted distance from the caterpillar tracks of the excavator to the kaolin face ($C = 1$ m).

With a frost depth in the kaolin of 1.2 m and using the ZER-500 excavator ($f = 1.275$ m; $l_{rj} = 14$ m; $\beta = 15^\circ$; $B = 11.16$ m; $\alpha = 65^\circ$) the minimum angle of rotation of the excavator toward the offloading side is $32^\circ$.

To guarantee safe operation of the belt conveyer, when completing repairs, in order to prevent the conveyer from getting clogged up with deflocculated kaolin from the face, the minimum permissible distance $a$ from the lower edge of the bench to the axis of the conveyer should be less than 5 m.

The relationship $a = f(\psi_M)$ is shown in Fig. 1. A distance of 5 m from the axis of the conveyer to the step will be assured only with a rotary angle of the rotor jib toward the offloading side of $28^\circ$, and for reliable operation of the excavator the necessary minimum angle is $32^\circ$.

Consequently to ensure stable operation of the ZER-500 excavator it is necessary to use it in combination with an overloader. To select the minimum length of this overloader, it is necessary to take into account the maximum angle of rotation of the jib, $50^\circ$. This is satisfied by an overloader with a length $L_n$ of not less than 8.6 m (see Fig. 1).

The Giprostrom Institute designed, and the Glukhovets Kaolin Combine developed a self-driven overloader with a length of 13.5 m on the basis of the ZER-1001 excavator for kaolin pits which is moved to the face with a bulldozer. Using an excavator output determined by the capacity of the plant, displacement of the face is relatively slow and there is no difficulty with moving the overloader. The use of the overlacers and their parameters determine the setting width, the staging of the movements of the conveyer, and consequently the economics of the industrial scheme. The width of the excavator setting with a fixed jib is determined from the expression

$$S = (f + l_{rj} \cos \beta) \sin \psi_u + (f + l_{rj} \cos \beta \sin \psi_u + r) \sin \psi_u - H \cot \alpha,$$

where $\beta_u$ is the angle of inclination of the jib during operation of the upper part of the ledge or shelving, in degrees; $r$ is the radius of the rotor, m ($r = 2.5$ m); $\psi_u$ is the angle of rotation of the rotor jib toward the step, degrees ($\psi_u = 90^\circ$); $H$ is the height of the step or bench, m.

The following operational schemes for the ZER-500 rotary excavator are possible in combination with belt conveyers; the ZER-500 excavator works the kaolin directly on the conveyer. The angle of rotation of the jib toward the loading site is minimal ($28^\circ$), the maximum setting width $S$ with a bench height of 12.5 is 17.5 m. In autumn-spring periods this scheme is not used without the use of special mats.